LA-UR-13-27825
*Approved for public release; distribution is unlimited.*

| | |
|---|---|
| *Title:* | **Avian Monitoring at the TA-36 Minie Site, TA-39 Point 6, and TA-16 Burn Grounds** |
| *Author(s):* | Charles D. Hathcock and Jeanne M. Fair<br>Environmental Protection Division |
| *Intended for:* | RCRA Permitting Team and External |

## Table of Contents

## Executive Summary

Los Alamos National Security, LLC (LANS) biologists in the Environmental Protection Division at Los Alamos National Laboratory (LANL) initiated a multi-year monitoring program for migratory birds in Fiscal Year (FY) 2013 to monitor avifauna at two open detonation sites and one open burn site at LANL. The objectives of this on-going study are to monitor patterns and trends of bird abundance and diversity over time at these sites. LANS biologists completed the first year of this effort in 2013.

Three surveys were completed at each of the study sites at the Technical Area (TA)-36 Minie Site, the TA-39 Point 6, and the TA-16 Burn Grounds between May and July 2013. A total of 590 birds representing 55 species were recorded. Of the 55 species detected at the three study sites, 54 are protected under the Migratory Bird Treaty Act (MBTA).

Results indicate that the avian abundance and diversity at the three study sites were comparable to or greater than that of the control sites. Continued monitoring will produce trends over time in avian abundance and diversity that can be compared to local, regional, and national data.

## Introduction

As part of the Resource Conservation and Recovery Act (RCRA) permitting process for two open detonation sites, the TA-36 Minie Site and TA-39 Point 6, and one open burn site, the TA-16 Burn Grounds, at LANL, an avian monitoring program was started in 2013. The goal was to monitor avian use of the habitat surrounding the open detonation and open burning sites and compare their use to other locations at LANL in the same habitat type. Comparisons were made to control sites which have been surveyed since 2011 (Hathcock et al. 2011; Hathcock and Keller 2012).

LANS biologists used standard point count methodology to record avian density and diversity along transects in the three study sites during the summer of 2013. Summer surveys provide information about what migratory birds are breeding at the sites. These surveys are most valuable when they are conducted over multiple years, as they provide trend data, which can be compared with regional and national changes in bird populations, changes in the natural environment at LANL, and LANL operations.

## Methods

### Field Methods

Point count surveys along a transect were chosen as the most rigorous method to monitor patterns of bird abundance and richness, and population trends, in habitats found at two open detonation sites and one open burning site at LANL. This method is already used around LANL at other locations for long-term monitoring. The surveys were conducted along transects in the forested, undeveloped land surrounding the study sites (Figures 1 – 3). The habitat types around the sites are pinyon-juniper woodland (PJ) for the sites at TA-36 and -39 and mixed conifer forest (MC) for the site at TA-16. These habitat descriptions are based on the 1/4 hectare physiognomic cover classes in the LANL land cover map (McKown et al. 2003). The three study

sites were compared to control sites at LANL. The control sites (Figure 4) are monitored annually in ongoing surveys conducted at LANL since 2011 as described in Hathcock and Keller (2012). The PJ study sites at TA-36 and -39 are similar to the PJ control sites at TA-70 and -71 in elevation, vegetation, proximity to developed areas, and in being situated on the mesa top. The MC study site at the TA-16 Burn Grounds is similar in elevation, and overstory vegetation, but is dissimilar in that the study site is located on a mesa top and the control sites are located in the bottom of a canyon. Being the bottom of a canyon, there are some differences in understory vegetation with a greater understory present in the control sites.

Transects are approximately 2.0 to 2.5 km in length and allow for nine survey points spaced approximately 250 m apart. These survey routes and points may change over time due to construction activities or access constraints. The time frame for breeding bird surveys is May 1st – August 15. Ideally the breeding bird surveys should take place in the 2$^{nd}$ week of May, June, and July. This protocol requires a total of three surveys per study site and surveys should be conducted between 0.5 hours before sunrise and 4 hours after sunrise.

The following steps apply to breeding bird surveys.

- Each survey consists of nine points along the transect, ~ 250 m apart
- At each point of the survey the surveyor will look and listen for 5 minutes, noting any birds encountered. The distance for observations is considered as an "unlimited-distance circular plot"; however, noting the distance to each bird out to 100 meters should be done. Care is needed to ensure that individual birds are not re-counted from point to point. Use a range finder when possible for measuring the distance.
- While walking between points, any birds encountered that have not otherwise been counted from a previous point or future point should also be noted. It should not be the intent for the surveyor to dawdle between points looking for additional birds.
- Surveys should not be conducted during rain events or wind greater than 25 kph.
- Any bird(s) encountered will be recorded on the data sheet. For each observation, the minimum data collected should be point number, time, species, number of individuals, and distance from the point.
- The "NOTES" section should be used for indicating any potentially important aspects of the survey that may affect the data. Examples include: excess noise from nearby equipment and vehicles or aircraft that make it hard to hear the birds. Also, noting other wildlife or evidence of wildlife that could be used for further reference should be recorded.

## Statistical Methods

Summary statistics are compiled to look at trends in avian abundance and diversity between the three study sites and the control sites. To compare relative abundances between years and with control sites, the "birds per hour" was calculated for each site. This was calculated by taking the total number of birds per habitat type and dividing by the total number of minutes surveyed. Then this number is multiplied by 60 to get the number of birds per hour.

The Shannon's diversity index (*H*) (Shannon 1948) was used to examine species diversity by location and habitat type. This diversity index is a popular measure in ecology that is used to describe the species richness in a community. The Shannon's *H* can range from 0.0 to 4.6, where larger values represent increasing diversity. *H* is calculated using the following formula:

$H = -1\ (p_i\ (\ln\ (p_i))$

Where $p_i$ is a percentage value of a specific species in the total population and ln is the natural log.

Another useful measure is the Shannon's equitability estimate ($E_H$) (Shannon 1948) which is a measure of evenness in the population. This measures the evenness with which individuals are divided among the taxa present. This measure ranges from 0 to 1 where one represents a completely even community in which all species' abundances are equal. The Shannon's $E_H$ is calculated using the following formula:

$E_H = H/\ln S$

Where S is species count, ln is the natural log, and *H* is the Shannon's diversity index.

To compare indices, a bootstrapping technique is used where two samples, A and B, are pooled. Then 1,000 random pairs of samples (Ai and Bi) are taken from this pool, with the same numbers of individuals as in the original two samples. For each replicate pair, the diversity indices div(Ai) and div(Bi) are computed. The number of times |div(Ai)-div(Bi)| exceeds or equals |div(A)-div(B)| indicates the probability that the observed difference could have occurred by random sampling from one parent population as estimated by the pooled sample. A small probability value less than 0.05 indicates a significant difference in the diversity index between the two samples. The diversity indices and the bootstrap comparisons between indices were completed using the PAST statistical software (Hammer et al. 2001).

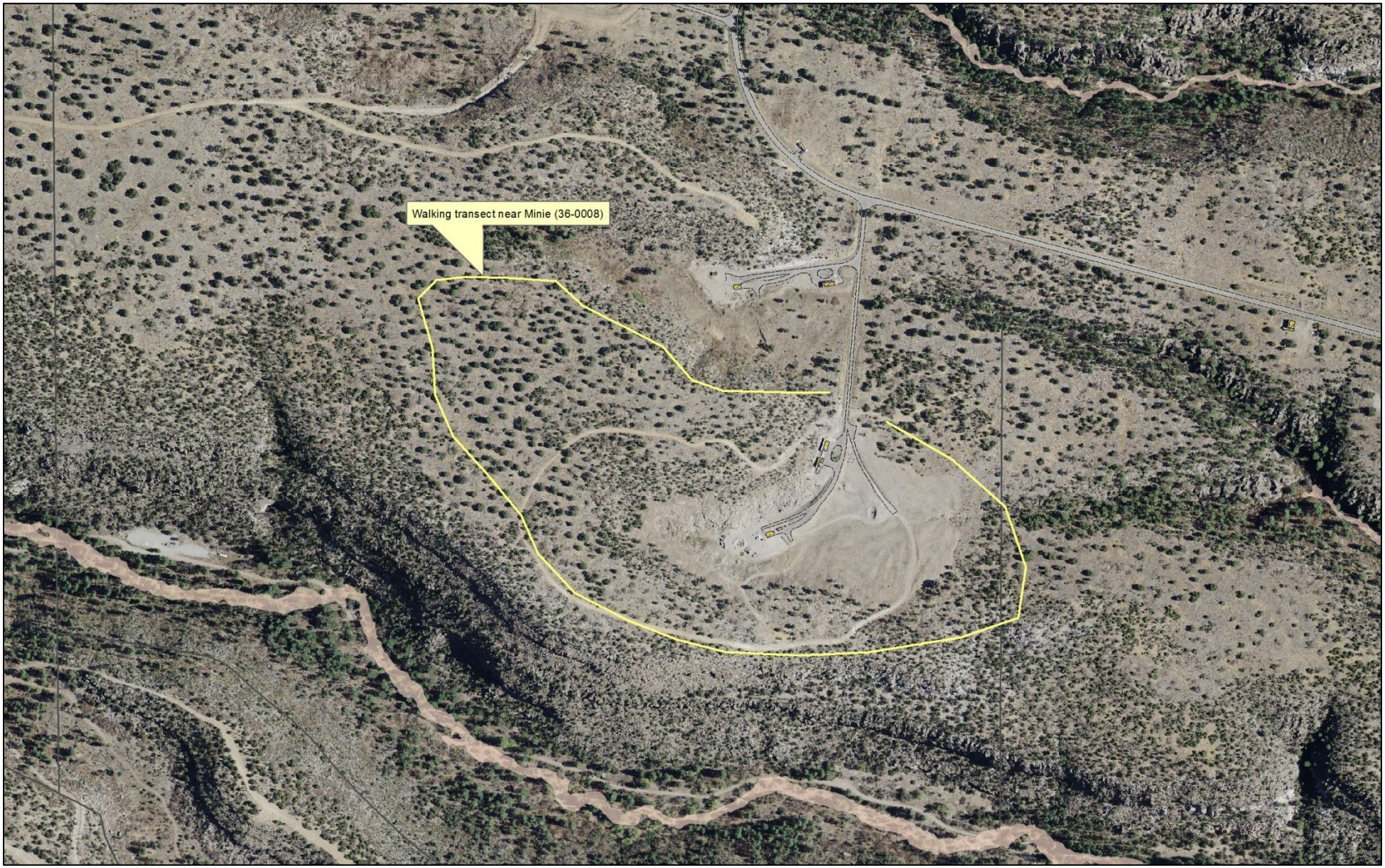


Figure 1. Field Working Map for the Transect Around the TA-36 Minie Site.

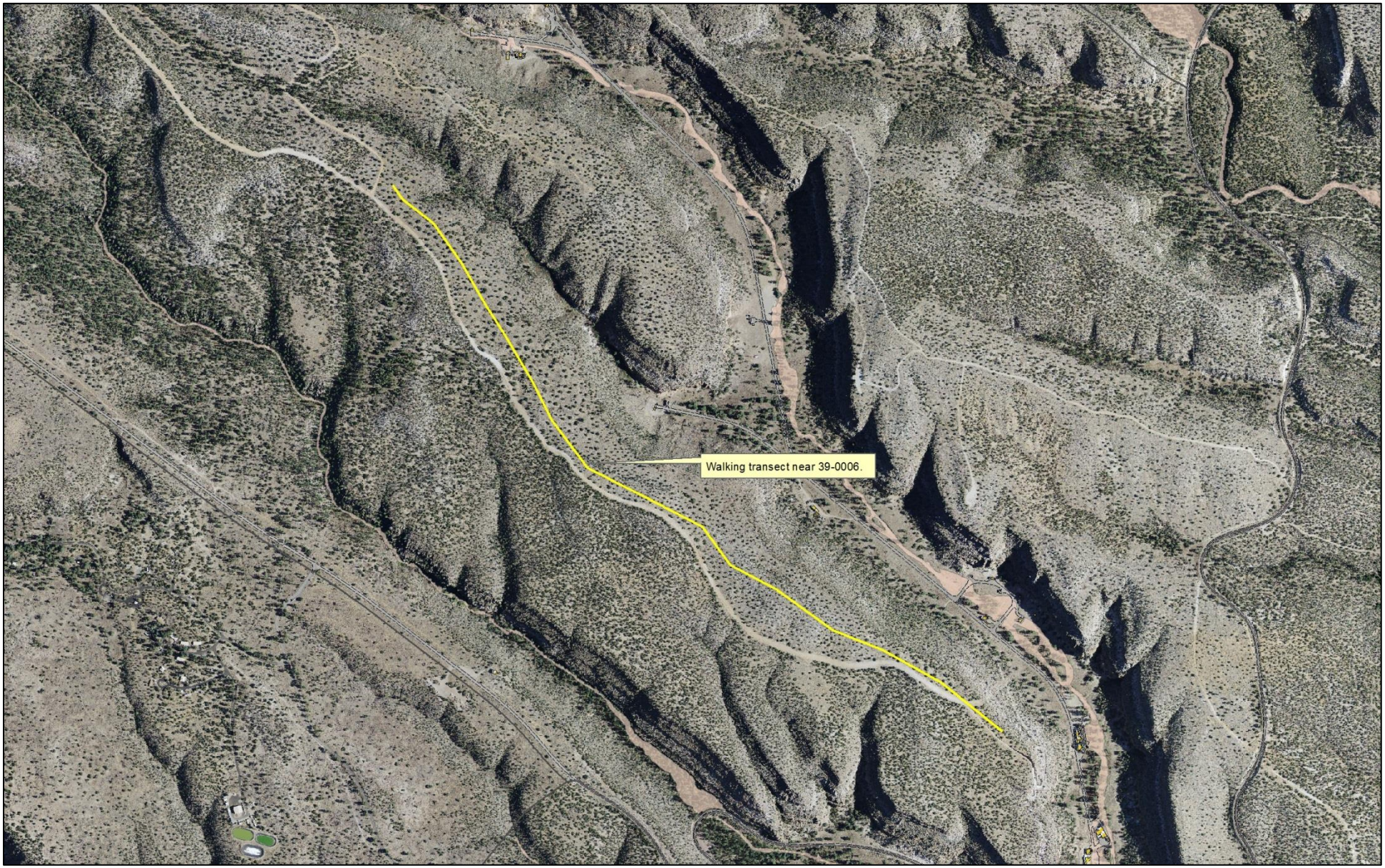


Figure 2. Field Working Map for the Transect Around the TA-39 Point 6.

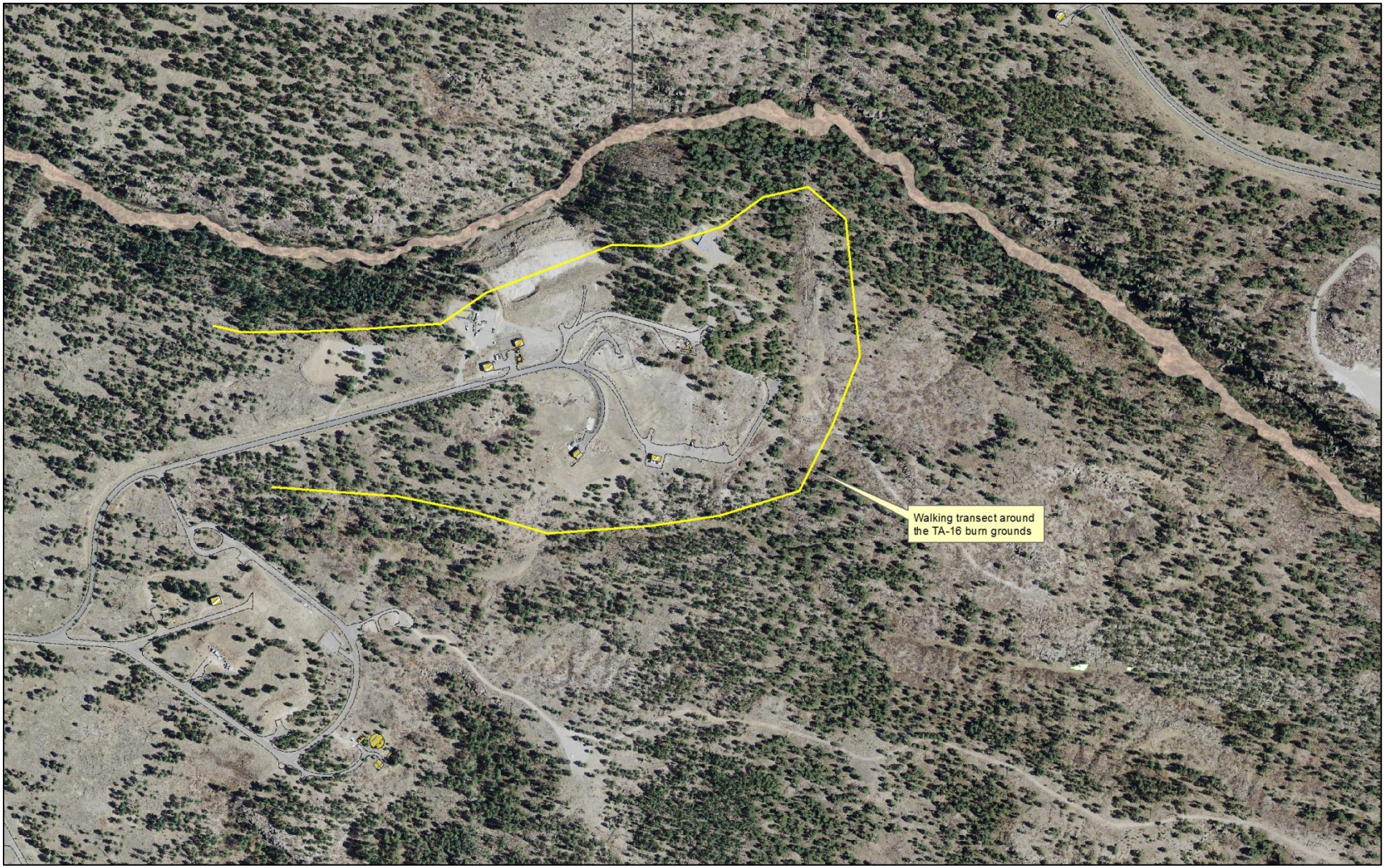


Figure3. Field Working Map for the Transect Around the TA-16 Burn Grounds.

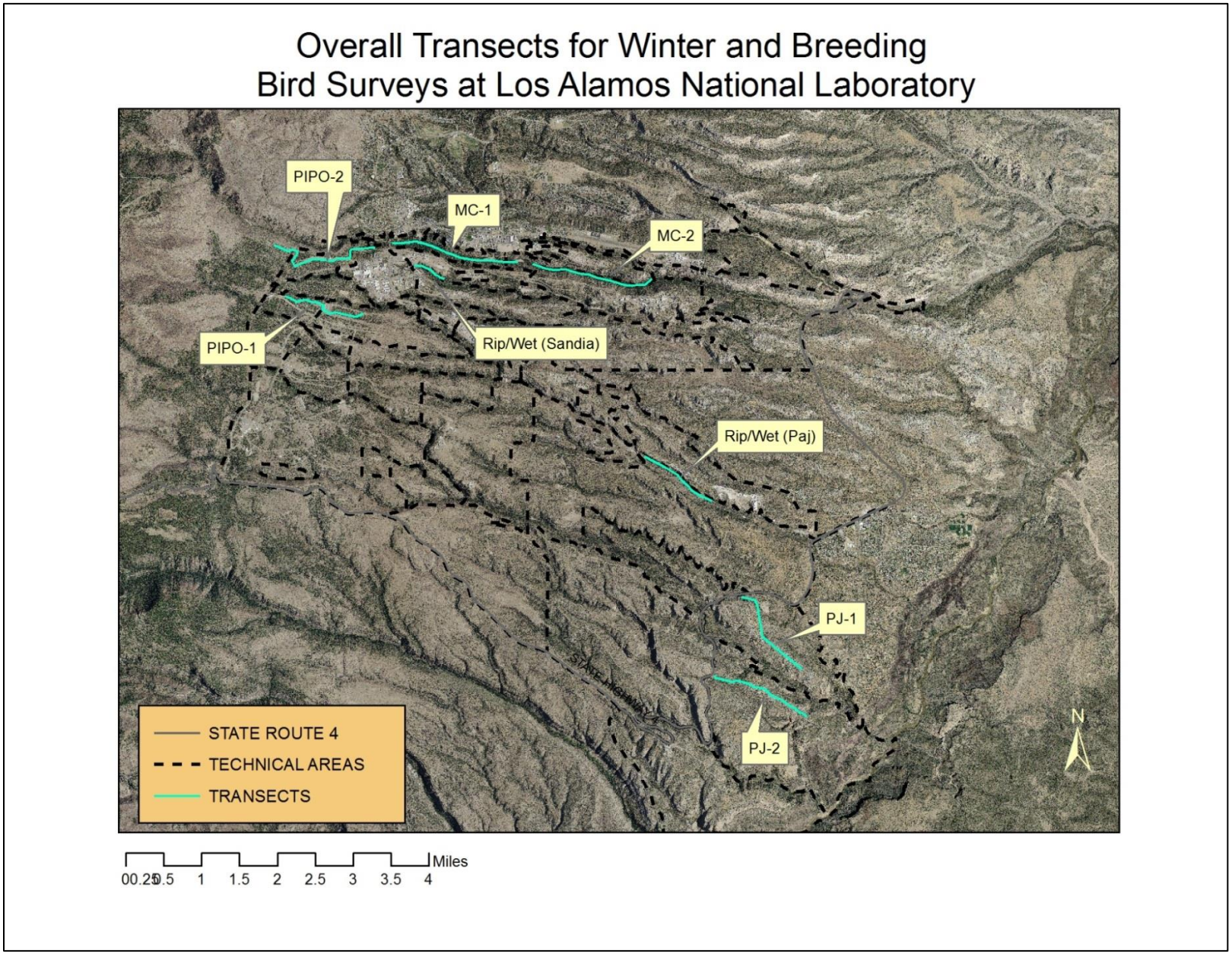


Figure 4. Control Transects from Ongoing Avian Monitoring Around LANL (Hathcock and Keller 2012). MC: Mixed Conifer Forest, PIPO: Ponderosa Pine Forest, PJ: Pinyon-Juniper Woodland, Rip/Wet: Riparian / Wetland.

**Results and Discussion**

Three surveys were completed at the TA-36 Minie Site, TA-39 Point 6, and TA-16 Burn Grounds between May and July 2013. A total of 590 birds representing 55 species were recorded. The ten most common species at these three sites were the House Finch, Spotted Towhee, Western Bluebird, Mourning Dove, Ash-throated Flycatcher, Pine Siskin, Western Wood-Pewee, Juniper Titmouse, Gray Flycatcher, and Plumbeous Vireo. A full account of the 2013 data is detailed in Table 1.

Table 1. Birds Recorded at the Three Study Sites in 2013.

| Species Name | TA-36 Minie Site (PJ Habitat) | TA-16 Burn Grounds (MC Habitat) | TA-39 Point 6 (PJ Habitat) |
|---|---|---|---|
| Acorn Woodpecker | | 5 | |
| American Kestrel | | | 1 |
| American Robin | 1 | 7 | 1 |
| Ash-throated Flycatcher | 11 | 3 | 19 |
| Audubon's Warbler | | 6 | |
| Bewick's Wren | 4 | | 3 |
| Black-chinned Hummingbird | | 1 | 3 |
| Black-headed Grosbeak | 1 | | |
| Black-throated Gray Warbler | | | 5 |
| Blue-gray Gnatcatcher | 3 | | 2 |
| Broad-tailed Hummingbird | 2 | 5 | 3 |
| Brown Creeper | | 1 | |
| Brown-headed Cowbird | 1 | 4 | |
| Bushtit | | | 2 |
| Canyon Towhee | 2 | 1 | 1 |
| Chipping Sparrow | 3 | 1 | 6 |
| Common Nighthawk | 6 | | 5 |
| Common Raven | 2 | 5 | 1 |
| Cooper's Hawk | | 1 | |
| Cordilleran Flycatcher | | 5 | |
| Dark-eyed Junco | | 6 | |
| Eurasian Collared-Dove | 3 | | |
| Evening Grosbeak | 3 | 5 | |
| Grace's Warbler | | 6 | |
| Gray Flycatcher | 12 | | 10 |
| Great Horned Owl | | | 1 |
| Green-tailed Towhee | 3 | | 1 |
| Hairy Woodpecker | | 1 | |

| | | | |
|---|---|---|---|
| Hammond's Flycatcher | | 8 | |
| House Finch | 16 | 16 | 21 |
| House Wren | | 1 | |
| Juniper Titmouse | 12 | | 11 |
| Lesser Goldfinch | 2 | 3 | 4 |
| Mountain Chickadee | 5 | 5 | |
| Mourning Dove | 17 | 4 | 13 |
| Pine Siskin | 10 | 12 | 6 |
| Plumbeous Vireo | 10 | 11 | 1 |
| Pygmy Nuthatch | | 11 | |
| Red-shafted Flicker | 3 | 3 | 3 |
| Rock Wren | 3 | 1 | 7 |
| Say's Phoebe | 2 | 1 | 2 |
| Spotted Towhee | 17 | 11 | 12 |
| Steller's Jay | | 3 | |
| Townsend's Solitaire | 1 | | |
| Turkey Vulture | | 1 | |
| Violet-green Swallow | | | 6 |
| Virginia's Warbler | | 17 | |
| Warbling Vireo | | 2 | |
| Western Bluebird | 15 | 20 | 5 |
| Western Kingbird | 6 | | 7 |
| Western Scrub-Jay | 5 | 1 | 8 |
| Western Tanager | | 2 | |
| Western Wood-Pewee | 10 | 15 | |
| White-breasted Nuthatch | 1 | 9 | |
| White-winged Dove | 1 | | 7 |
| **Grand Total** | **193** | **220** | **177** |

The bird surveys were analyzed to determine the "birds per hour", which is a measure of relative abundance, for each of the three study sites as well as the control sites of the comparable habitat type (Figure 5). The birds per hour were similar between the three study sites and the associated control sites. The TA-16 Burn Grounds site was slightly lower in bird per hour than the MC control sites, but not significantly lower ($t_{3,1}$=3.506, p = 0.07). Error bars were calculated for the control sites since multiple years of data were available. The birds per hour for the TA-16 Burn Grounds was within 2 standard deviations of the mean of the MC control sites (Figure 5). The TA-36 Minie Site and TA-39 Point 6 were very similar to the PJ control sites ($t_{3,1}$=0.717, p = 0.54 and $t_{3,1}$=1.274, p = 0.33).

As described in the next section, the diversity and evenness of the avian community at the TA-16 Burn Grounds were not significantly different than the MC control sites. One possible reason for the lower birds per hour measurement, albeit not significantly lower, at the TA-16 Burn Grounds

was related to the control sites that were used. Selecting a control site is one of the fundamental issues when designing an ecological study. In this study the control sites are based on previous and ongoing work at LANL, and the two control sites for the MC habitat are located along the bottom of Los Alamos Canyon. The birds per hour can be slightly different when MC on a mesa-top, such as the TA-16 Burn Grounds, is compared with similar habitat in the bottom of a canyon. There are also species of birds, such as the Common Raven, that are seen in high numbers in Los Alamos Canyon due to close proximity to the townsite.

The 2013 results indicate that the relative abundance of the bird communities at the three study sites were not significantly different than the control sites.

The Shannon's diversity indices are detailed in Table 2. The TA-16 Burn Grounds showed the largest diversity of bird species, which was expected since it is primarily MC habitat. A bootstrapping technique using 1,000 permutations was used to compare the diversity indices.

Compared to the control sites, the diversity and evenness of the TA-16 Burn Grounds were not significantly different than both the 2013 data ($p=0.53$ and 0.57) and the pooled data from 2011-2013 ($p=0.11$ and 0.17).

Compared to the control sites, the diversity of the TA-36 Minie Site was not significantly different than the 2013 data ($p=0.38$) and the pooled data ($p=0.66$). However, the evenness of the TA-36 Minie Site was significantly larger than the control sites for both the 2013 data as well as the pooled data ($p=0.001$ and 0.003).

Compared to the control sites, the diversity at TA-39 Point 6 was significantly larger than the 2013 data ($p=0.03$) and larger than the pooled data, but not significantly ($p=0.13$). The evenness of the TA-39 Point 6 was significantly larger than the control sites for both the 2013 data as well as the pooled data ($p=0.003$ and 0.017).

These results indicate that the bird diversity and evenness of the avian communities at the study sites are comparable to or greater than the control sites, with some being significantly greater. This indicates a healthy avian population at the study sites.

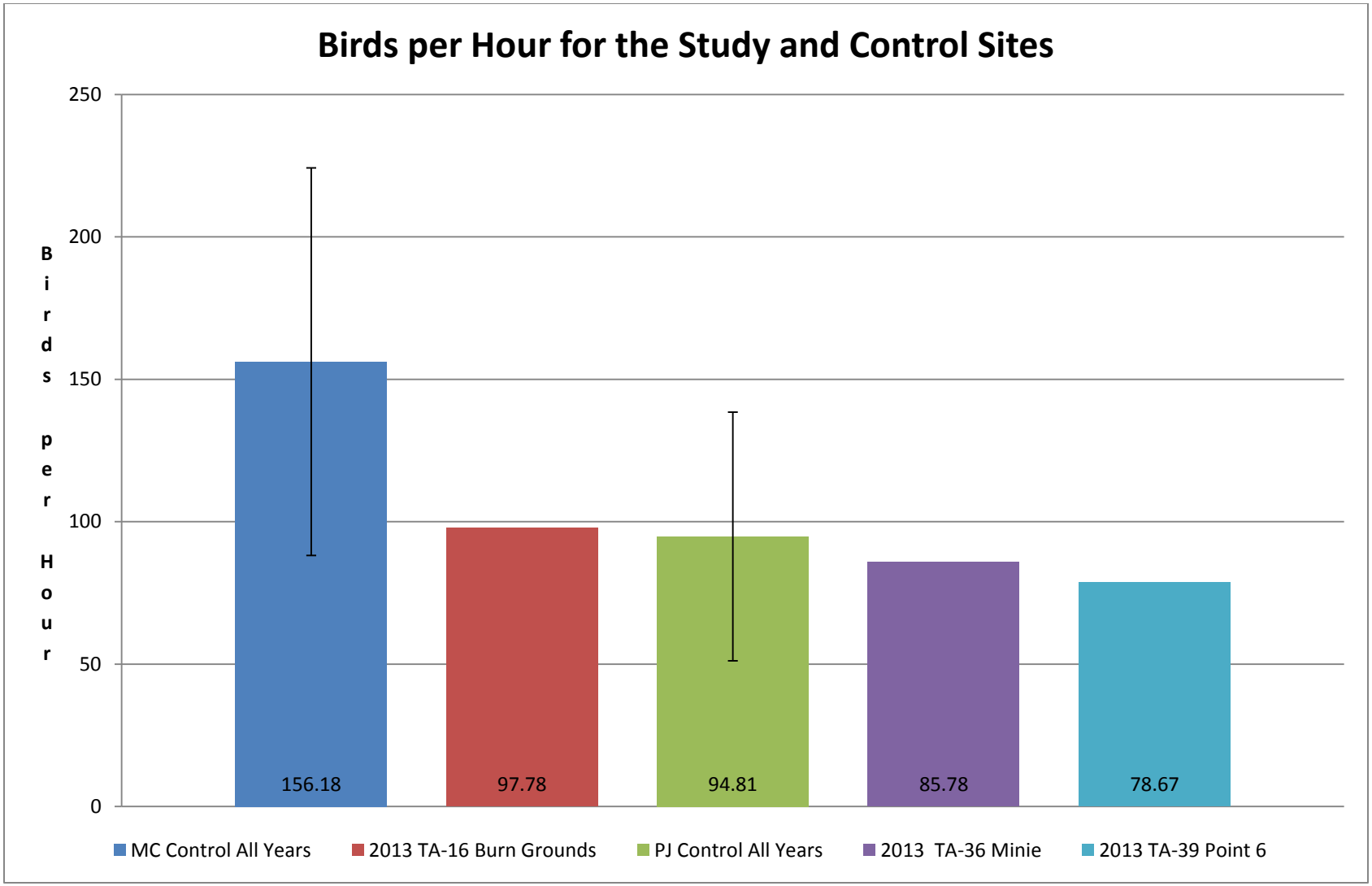


Figure 5. Birds per Hour for the Study and Control Sites. Error Bars are +/- 2 Standard Deviations. MC: Mixed Conifer Forest, PJ: Pinyon-Juniper Woodland.

Table 2. Shannon Values for the Study Sites and Control Sites; Statistically Significant Results are Bolded. MC: Mixed Conifer Forest, PJ: Pinyon-Juniper Woodland.

| Transect Name | Diversity Index (H) | 2013 PJ Control Sites Diversity Index (H) | All Years PJ Control Sites Diversity Index (H) | 2013 MC Control Sites Diversity Index (H) | All Years MC Control Sites Diversity Index (H) |
|---|---|---|---|---|---|
| TA-36 Minie Site (PJ) | 2.942 | 2.832 | 2.878 | | |
| TA-39 Point 6 (PJ) | 3.09 | **2.832 (p=0.03)** | 2.878 | | |
| TA-16 Burn Grounds (MC) | 3.304 | | | 3.383 | 3.501 |
| | | | | | |
| Transect Name | Equitability Index (EH) | 2013 PJ Control Sites Equitability Index (EH) | All Years PJ Control Sites Equitability Index (EH) | 2013 MC Control Sites Equitability Index (EH) | All Years MC Control Sites Equitability Index (EH) |
| TA-36 Minie Site (PJ) | 0.729 | **0.5143 (p=0.001)** | **0.4805 (p=0.003)** | | |
| TA-39 Point 6 (PJ) | 0.709 | **0.5143 (p=0.003)** | **0.4805 (p=0.017)** | | |
| TA-16 Burn Grounds (MC) | 0.6983 | | | 0.6269 | 0.6269 |

In addition to supporting federally protected species such as the Mexican Spotted Owl and the Southwestern Willow Flycatcher, LANL lands are important for understanding migratory bird conservation. Of the 55 species detected at the three study sites, 54 are protected under the MBTA. Additionally, two of the species detected at the three study sites are on the Birds of Conservation Concern Region 16 list, the Southern Rockies/Colorado Plateau region (USFWS 2008). Those two species are the Juniper Titmouse and Grace's Warbler. The primary statutory authority for Birds of Conservation Concern is the Fish and Wildlife Conservation Act of 1980. Another conservation tool used in migratory bird management is the Birder's Conservation Handbook (Wells 2007), which lists the top 100 birds most at risk in North America. Two species detected at the three study sites are on the top 100 list. These two species are the Virginia's Warbler and Grace's Warbler.

**Avian Nestbox Network**

In 1997, an avian nestbox monitoring network was established on LANL, Los Alamos County land, and U.S. Forest Service land to investigate the health and condition of cavity-nesting bird populations on the Pajarito Plateau. The purpose of this study was to evaluate the magnitude and sources of ecological risks from contaminants and other environmental stressors for cavity-nesting birds at LANL. The main objective was to evaluate the ecological and physiological costs of exposure to various contaminants at LANL and their potential impact on population processes. In 2011, nestboxes were added to the TA-36 Minie Site and TA-39 Point 6 to investigate any potential impacts to cavity-nesting birds (Figures 6 and 7).

On Sept 17th 2012, the Environmental Protection Division received notification from the Waste Facilities Operations Facility Operations Director of potential fire suppression/tree removal activities near archaeological sites near the TA-36 Minie firing site. Nestboxes were removed from trees as part of the fuels mitigation activities. These nestboxes were replaced for the 2013 breeding season and monitoring resumed at TA-36 Minie Site for the summer breeding season. However, the habitat was significantly impacted in the area around TA-36 Minie Site by the removal of trees.

Due to the drought and the lower elevation of the nestboxes at TA-39 Point 6, no birds nested in the nestboxes in 2013. However, TA-36 Minie Site had two nests in the nestboxes in 2013. There was one Mountain Bluebird nest that hatched four eggs and one Western Bluebird nest that presumably hatched and fledged nestlings. Due to the extreme drought conditions in 2013, field work was under fire restrictions and nestboxes were not checked until July 1st, thus all baseline monitoring measurements were not collected. Due to the small sample size, no statistical comparisons can be made at this time to the over 500 nestboxes located throughout LANL and the Pajarito Plateau. However, due to the dry summer of 2013, most locations in the avian nestbox network had a decrease in hatching and fledgling success. For example, the percent of eggs hatched in 2013 was 68.12% compared to all previous years hatching success of 77-95%. Fledgling success was 67.55%, which in our study is highly dependent on elevation of the location. However, there are not noticeable differences in the four nests total that have hatched in the last two years at the TA-36 Minie Site, with a 100% hatch and fledge rate.

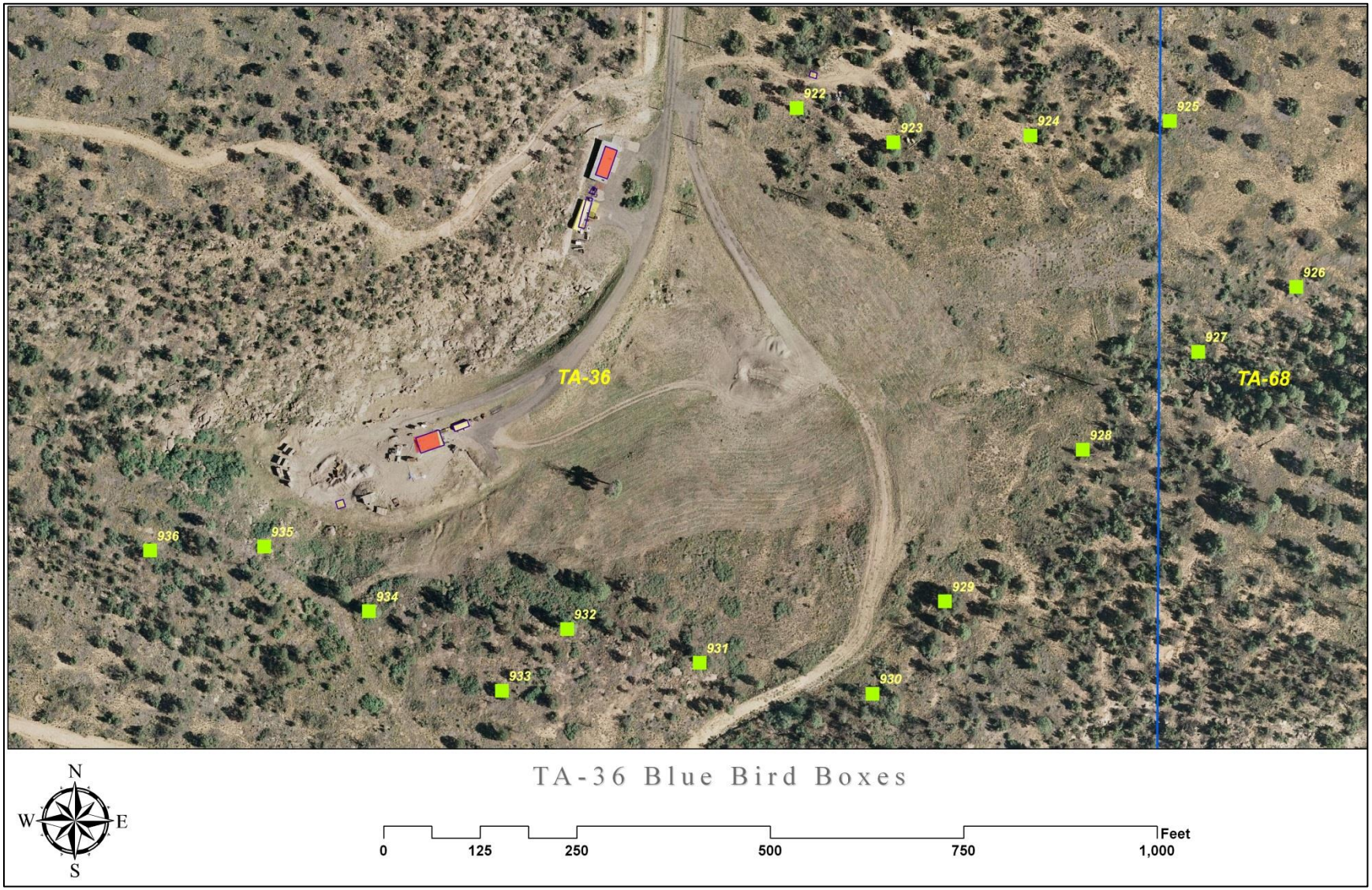


Figure 6. Avian Nestboxes Located at TA-36 Minie Site.


Figure 7. Avian Nestboxes Located at TA-39 Point 6.

## Management Recommendations

Continuing the research reported herein will provide a long-term dataset on the ecological health of LANL's avifauna at the three study sites, contribute to meeting the Department of Energy's commitments under the MBTA, and allow LANL to contribute to national goals in avian conservation monitoring and research.

## Acknowledgments

We'd like to thank Leslie Hansen, David Keller, Hallie Mahowald, and Luciana Vigil-Holterman for comments on earlier versions of this report and Anne Jacobs, Maria Musgrave, Audrey Smith, and Kari Schoenberg for field help during this project.

## Literature Cited

Hammer, Ø., Harper, D.A.T., and P. D. Ryan, 2001. PAST: Paleontological Statistics Software Package for Education and Data Analysis. Palaeontologia Electronica 4(1): 9pp.

Hathcock, C.D., K. Zemlick, and B. Norris. 2011. Winter and Breeding Bird Surveys at Los Alamos National Laboratory Progress Report for 2010 to 2011. LA-UR-11-05054. Los Alamos National Laboratory, Los Alamos, NM.

Hathcock, C.D. and D.C. Keller. 2012. Winter and Breeding Bird Surveys at Los Alamos National Laboratory Progress Report for 2010 to 2012. LA-UR-12-25120. Los Alamos National Laboratory, Los Alamos, NM.

McKown, B., S.W. Koch, R.G. Balice, and P. Neville. 2003. Land cover classification map for the Eastern Jemez Region. LA-14029. Los Alamos National Laboratory, Los Alamos, NM.

Shannon C.E. 1948. A Mathematical Theory of Communication. Bell Syst. Tech. J. 27:379-423.

U.S. Fish and Wildlife Service (USFWS). 2008. Birds of Conservation Concern 2008. United States Department of Interior, Fish and Wildlife Service, Division of Migratory Bird Management, Arlington, Virginia. 85 pp.

Wells, J.V. 2007. Birder's Conservation Handbook: 100 North American Birds At Risk. Princeton University Press. Princeton, New Jersey. 452 pp.